CLAIMS

What is claimed is:

1. A self-valving vacuum distribution system for a belt-driven sheet transfer apparatus comprising:

a vacuum plenum having a flat surface over which a pair of spaced conveyor belts operate to define an open vacuum channel; and,

vacuum control valves spaced along the channel in the plenum surface, said valves held closed by a high pressure differential between the vacuum plenum and the open vacuum channel and biased to open under a reduced pressure differential between the vacuum plenum and the vacuum channel when the channel is covered by a sheet carried over the channel on the conveyor belts.

2. The apparatus as set forth in claim 1 including a vacuum starter opening in the plenum surface upstream of the control valves providing initial vacuum communication between the plenum and the upstream end of the vacuum channel.

3. The apparatus as set forth in claim 2 including an infeed device adapted to move a line of spaced sheets in series into contact with the conveyor belts and to cause the leading edge of each sheet to override the vacuum starter opening and each control valve in succession, thereby progressively covering the vacuum channel and reducing the pressure differential to said reduced level allowing the valves to be biased open.

4. The apparatus as set forth in claim 3 wherein passage of the trailing edge of each sheet over the control valves causes the valves to progressively close.

5. The apparatus as set forth in claim 3 wherein the conveyor belts have flat coplanar conveying surfaces, and the plenum surface between the belts is recessed from the conveying surfaces to form said vacuum channel.

6. The apparatus as set forth in claim 3 wherein each of said control valves comprises:

a flat resilient metal plate operatively connected by an edge to the plenum surface, said plate having a closure face bent away at an acute angle from the plane of the surface to provide the bias to open at said reduced pressure differential; and,

a vacuum opening in the plenum surface providing vacuum communication between the plenum and the vacuum channel, said vacuum opening aligned with the valve plate and closed thereby at said high pressure differential.

7. The apparatus as set forth in claim 2 comprising:

a plurality of laterally adjacent vacuum channels, each channel providing support for an incremental width of a sheet; and,

said vacuum plenum operatively connected to said adjacent vacuum channels.

8. The apparatus as set forth in claim 7 wherein each of said control valves includes a vacuum opening in the plenum surface providing vacuum communication between the plenum and the vacuum channel, and a valve plate attached to the plenum surface and operative to seal the vacuum opening against the valve bias at said high pressure differential.

9. The apparatus as set forth in claim 8 including a starter vacuum conduit controlled by the control valve to provide the plenum vacuum pressure to the starter opening of the next laterally adjacent vacuum channel when said sheet is wide enough to cover said next adjacent vacuum channel.

10. The apparatus as set forth in claim 9 wherein said starter vacuum conduit includes a vacuum inlet end in the plenum surface and a vacuum outlet end having an open connection to the vacuum starter opening in said next adjacent vacuum channel, and wherein said valve plate is operative to close said inlet end at said high pressure differential and to open said inlet end at said reduced pressure differential.

11. The apparatus as set forth in claim 10 including a starter vacuum conduit connecting the plenum surfaces of each pair of laterally adjacent vacuum channels.

12. The apparatus as set forth in claim 11 comprising a vacuum starter opening in each third vacuum channel and starter vacuum conduit operatively connecting each vacuum starter opening with the next two adjacent vacuum channels

13. A sheet-actuated vacuum assisted sheet conveyor for the continuous transfer of sheets delivered in serial spaced relation, said conveyor comprising:

a pair of laterally spaced, coplanar, parallel driven flat conveyor belts operating over a surface of a vacuum plenum, the plenum surface between the belts recessed from the coplanar flat belts to define a shallow vacuum channel;

a plurality of vacuum control valves in said vacuum surface spaced in the direction of conveyor belt movement and providing vacuum communication between the plenum and the vacuum channel;

said control valves operative to be held closed by a negative pressure in the plenum sufficient to create a first pressure differential across the valve, said valves biased to open for vacuum communication at a second pressure differential across the valve less than the first pressure differential;

means for moving sheets into planar contact with the conveyor belts in a manner that progressively covers said vacuum channel;

means for applying the plenum vacuum to an upstream end of the vacuum channel upstream of the upstreammost valve such that, as a sheet moves to progressively cover said vacuum channel, vacuum pressure in the channel moves in the downstream direction with the sheet to cause the pressure differential across each valve in succession to decrease to said second pressure differential and said valves to serially open, thereby applying the plenum vacuum directly to the sheet to hold the same against and to move with the conveyor belts.

14. The apparatus as set forth in claim 13 wherein said vacuum control valves each comprises:

a vacuum opening in the plenum surface of the vacuum channel; and,

a valve plate attached to the plenum surface and operative to seal the vacuum opening against the valve bias at said first pressure differential.

15. The apparatus as set forth in claim 14 wherein the valve plate comprises a thin spring steel plate attached at one edge to the plenum surface and permanently bent along a hinge line to define a flat body portion extending away from the surface at an actuate angle when the valve is open.

16. The apparatus as set forth in claim 13 wherein the means for applying the plenum vacuum pressure to the upstream end of the vacuum channel comprises a vacuum starter opening in the plenum surface.

17. The apparatus as set forth in claim 16 comprising a plurality of laterally adjacent vacuum channels operatively connected to the vacuum plenum, each channel providing support for an incremental width of a sheet.

18. The apparatus as set forth in claim 17 wherein the vacuum starter opening of each of the laterally adjacent vacuum channels is connected by a starter vacuum conduit to a directly adjacent vacuum channel such that plenum vacuum pressure in said directly adjacent channel when the control valve for said directly adjacent channel is open is communicated to the starter opening of said laterally adjacent channel.

19. The apparatus as set forth in claim 18 wherein each starter vacuum conduit includes a vacuum inlet end in the plenum surface of the directly adjacent vacuum channel.

20. The apparatus as set forth in claim 18 comprising a vacuum starter opening in each of a selected number of non-adjacent channels and starter vacuum conduits operatively connecting each of said vacuum starter openings with the serially adjacent vacuum channels.

21. The apparatus as set forth in claim 13 wherein each of said vacuum control valves comprises:

a vacuum opening in the plenum surface of the vacuum channel; and,

a poppet valve having a valve head adapted to cover and close the vacuum opening at said first pressure differential, and a valve spring operative to bias the valve head to open said vacuum opening at said second pressure differential.

22. A method for vacuum assisted transfer of sheets delivered in serial spaced relation, comprising the steps of:

(1) driving a pair of laterally spaced coplanar parallel flat conveyor belts over a surface of a vacuum plenum with the plenum surface between the belts recessed from the flat belts to define a shallow vacuum channel;

(2) positioning a plurality of vacuum control valves in said vacuum surface spaced in the direction of conveyor belt movement and providing fluid communication between the plenum and the vacuum channel;

(3) holding said control valves closed by generating a negative pressure in the plenum sufficient to create a first pressure differential across the valves;

(4) biasing said valves to open for fluid communication at a second pressure differential across the valves less than the first pressure differential;

(5) moving the sheets into planar contact with the conveyor belts to cause each sheet to progressively cover said vacuum channel;

(6) applying a starter vacuum pressure to an upstream end of the vacuum channel upstream of the upstreammost valve; and,

(7) utilizing a moving sheet to progressively cover said vacuum channel, causing the vacuum pressure in the channel to move downstream with the sheet, the pressure differential across each valve in succession to decrease to said second pressure differential, and said valves to serially open, thereby applying the plenum vacuum pressure directly to the sheet to hold the sheet against and to move with the conveyor belts.

23. The method as set forth in claim 22 including the steps of:

(1) providing a plurality of laterally adjacent vacuum channels;

(2) utilizing said adjacent channels to provide support for incremental widths of the sheet; and,

(3) transferring the negative plenum pressure from the vacuum channel to which the starter vacuum is applied to the upstream ends of said laterally adjacent vacuum channels serially in response to the opening of each respective control valve.

24. The method as set forth in claim 23 including the step of limiting the number of laterally adjacent vacuum channels to which negative plenum pressure is transferred.

25. The method as set forth in claim 24 wherein the limiting number of laterally adjacent vacuum channels is two.